

Claims

What is claimed is:

- 5 1. A method of processing water to create floodwater for ice-making, comprising:
mixing an additive into the water to produce floodwater having at least one
property selected from the group comprising:
 - (a) $180 \text{ mg/L} \leq \text{total alkalinity (CaCO}_3) \leq 200 \text{ mg/L}$,
 - (b) $9 \text{ mg/L} \leq \text{hardness (CaCO}_3) \leq 12 \text{ mg/L}$, and
 - 10 (c) $0 \text{ Nephelometric Turbidity Units} \leq \text{turbidity} \leq 1 \text{ Nephelometric Turbidity Units}$.
2. A method as claimed in Claim 1, further comprising: filtering the water to a commercially practical degree of purity before mixing the additive into the water.
3. A method as claimed in Claim 2, wherein filtering the water comprises at least one of:
 - 15 a) mechanically filtering the water,
 - b) deionizing the water, and
 - c) reverse-osmotically filtering the water.
4. A method as claimed in Claim 3, wherein water filtered to a commercially practical degree of purity is characterized by having:
 - 20 a) less than one part per million of each of aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, lead, lithium, molybdenum, nickel, phosphorus, selenium, silicon, silver, strontium, sulphur, thallium, vanadium, calcium, magnesium, manganese, sodium, potassium, chloride (Cl), sulphate (SO₄), hardness (CaCO₃),
25 bicarbonate alkalinity (HCO₃), hydroxide alkalinity (CO₃), carbonate alkalinity (OH),
 - b) less than five parts per million of total alkalinity (CaCO₃),
 - c) a turbidity between 0 - 1 Nephelometric Turbidity Units, and
 - d) a pH between 6.5 and 7.5.
- 30 5. A method as claimed in Claim 3, further comprising: heating the filtered water before mixing the additive into the water.

6. A method as claimed in Claim 1, wherein mixing an additive comprises mixing an additive into the water until the floodwater has at least one property selected from the group comprising:

- a) $7.5 \leq \text{pH} \leq 8.5$,
- 5 b) $190 \text{ mg/L} \leq \text{bicarbonate alkalinity (HCO}_3\text{)} \leq 210 \text{ mg/L}$,
- c) $8 \text{ mg/L} \leq \text{sulphate concentration (SO}_4\text{)} \leq 10 \text{ mg/L}$,
- d) $100 \text{ mg/L} \leq \text{sodium concentration (Na)} \leq 130 \text{ mg/L}$,
- e) $3 \text{ mg/L} \leq \text{calcium concentration (Ca)} \leq 6 \text{ mg/L}$,
- f) $55 \text{ mg/L} \leq \text{chloride concentration (Cl)} \leq 70 \text{ mg/L}$, and
- 10 g) $3 \text{ mg/L} \leq \text{silicon concentration (SiO}_2\text{)} \leq 7 \text{ mg/L}$.

7. A method as claimed in Claim 1, wherein mixing an additive comprises mixing a buffering salt into the filtered water.

8. A method as claimed in Claim 2, wherein mixing an additive comprises mixing into the filtered water a composition comprising: 74% by mass sodium
15 bicarbonate (NaHCO_3), 24% by mass sodium chloride (NaCl) and 2% by mass gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$).

9. A method as claimed in Claim 8, wherein mixing said composition into the filtered water comprises: mixing 36×10^{-2} grams of the additive into each litre of filtered water.

20 10. A method as claimed in Claim 2, wherein mixing an additive comprises:

- a) mixing said additive into a first amount of filtered water to create a mixture, and
- b) blending said mixture into a second amount of filtered water.

25 11. A composition of matter for mixing with water to create floodwater for making ice, such that the composition when added to water creates floodwater that has at least one property selected from the group comprising:

- a) $180 \text{ mg/L} \leq \text{total alkalinity (CaCO}_3\text{)} \leq 200 \text{ mg/L}$,
- b) $9 \text{ mg/L} \leq \text{hardness (CaCO}_3\text{)} \leq 12 \text{ mg/L}$, and
- 30 c) $0 \text{ Nephelometric Turbidity Units} \leq \text{turbidity} \leq 1 \text{ Nephelometric Turbidity Units}$.

12. A composition of matter as claimed in Claim 11, wherein the water has been purified to a commercially practical degree of purity.

13. A composition of matter as claimed in Claim 12, wherein the water is characterized by having:

5 a) less than one part per million of each of aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, lead, lithium, molybdenum, nickel, phosphorus, selenium, silicon, silver, strontium, sulphur, thallium, vanadium, calcium, magnesium, manganese, sodium, potassium, chloride (Cl), sulphate (SO₄), hardness (CaCO₃), bicarbonate alkalinity (HCO₃), hydroxide alkalinity (CO₃), carbonate alkalinity (OH),

10 b) less than five parts per million of total alkalinity (CaCO₃),

c) a turbidity between 0 - 1 Nephelometric Turbidity Units, and

d) a pH between 6.5 and 7.5.

14. A composition of matter as claimed in Claim 12, wherein the floodwater has at least one property selected from the group comprising:

15 a) $7.5 \leq \text{pH} \leq 8.5$,

b) $190 \text{ mg/L} \leq \text{bicarbonate alkalinity (HCO}_3\text{)} \leq 210 \text{ mg/L}$,

c) $8 \text{ mg/L} \leq \text{sulphate concentration (SO}_4\text{)} \leq 10 \text{ mg/L}$,

d) $100 \text{ mg/L} \leq \text{sodium concentration (Na)} \leq 130 \text{ mg/L}$,

e) $3 \text{ mg/L} \leq \text{calcium concentration (Ca)} \leq 6 \text{ mg/L}$,

20 f) $55 \text{ mg/L} \leq \text{chloride concentration (Cl)} \leq 70 \text{ mg/L}$, and

g) $3 \text{ mg/L} \leq \text{silicon concentration (SiO}_2\text{)} \leq 7 \text{ mg/L}$.

15. A composition of matter as claimed in Claim 12, wherein the composition comprises a buffering salt.

25 16. A composition of matter as claimed in Claim 12, wherein the composition comprises:

a) 74% by mass sodium bicarbonate (NaHCO₃),

b) 24% by mass sodium chloride (NaCl), and

c) 2% by mass gypsum (CaSO₄·2H₂O).

17. A composition of matter for making ice, comprising a mixture of:

30 a) water having a commercially practical degree of purity, and

b) 36×10^{-2} grams of the composition of Claim 16 for each litre of water.

18. A composition of matter for making ice, the composition comprising water that has a property selected from the group consisting of:

- a) $180 \text{ mg/L} \leq \text{total alkalinity (CaCO}_3) \leq 200 \text{ mg/L}$,
- b) $9 \text{ mg/L} \leq \text{hardness (CaCO}_3) \leq 12 \text{ mg/L}$, and
- c) $0 \text{ Nephelometric Turbidity Units} \leq \text{turbidity} \leq 1 \text{ Nephelometric Turbidity Units}$.

19. A composition of matter as claimed in Claim 18, wherein the composition further has a property selected from the group consisting of:

- a) $7.5 \leq \text{pH} \leq 8.5$,
- b) $190 \text{ mg/L} \leq \text{bicarbonate alkalinity (HCO}_3) \leq 210 \text{ mg/L}$,
- c) $8 \text{ mg/L} \leq \text{sulphate concentration (SO}_4) \leq 10 \text{ mg/L}$,
- d) $100 \text{ mg/L} \leq \text{sodium concentration (Na)} \leq 130 \text{ mg/L}$,
- e) $3 \text{ mg/L} \leq \text{calcium concentration (Ca)} \leq 6 \text{ mg/L}$,
- f) $55 \text{ mg/L} \leq \text{chloride concentration (Cl)} \leq 70 \text{ mg/L}$, and
- g) $3 \text{ mg/L} \leq \text{silicon concentration (SiO}_2) \text{ between } \leq 7 \text{ mg/L}$.

20. A composition of matter as claimed in Claim 18, wherein the composition further comprises a buffering salt.

21. A composition of matter as claimed in Claim 18, wherein the composition further comprises:

- a) 26×10^{-2} grams of sodium bicarbonate (NaHCO_3) for each litre of water,
- b) 84×10^{-3} grams of sodium chloride (NaCl) for each litre of water, and
- c) 96×10^{-4} grams of gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) for each litre of water.

22. An apparatus for processing water into floodwater for making ice, comprising:

- a) a mixer connected to receive water having a commercially practical degree of purity and to receive an additive and operable to mix the water and the additive to create a floodwater mixture.

23. An apparatus as claimed in Claim 22, further comprising:

- a) a filtration stage operable to filter water and connected to supply the filtered water to the mixer.

24. An apparatus as claimed in Claim 23, wherein the filtration stage further comprises at least one of:

- a) a mechanical filter,
- b) a deionization filter, and
- c) a reverse-osmosis filter.

25. An apparatus as claimed in Claim 22, further comprising:

- 5 a) a heater operable to heat water and connected to supply the heated water to the mixer.

26. An apparatus as claimed in Claim 22, further comprising: a dispensing valve operable to control the amount of additive dispensed into the mixer for mixing with the water.

- 10 27. An apparatus as claimed in Claim 26, further comprising: a mix-tester operable to test a property of the mixture within the mixer.

28. An apparatus as claimed in Claim 27, wherein the mix-tester is operable to test at least one property selected from the group comprising:

- 15 a) total alkalinity (CaCO_3),
 b) hardness (CaCO_3), and
 c) turbidity.

29. An apparatus as claimed in Claim 28, wherein mix-tester is operable to test at least one property selected from the group comprising:

- 20 a) pH,
 b) bicarbonate alkalinity (HCO_3),
 c) sulphate concentration,
 d) sodium concentration (Na),
 e) calcium concentration (Ca),
 f) chloride concentration (Cl), and
25 g) silicon concentration (SiO_2).

30. An apparatus as claimed in Claim 27, wherein the dispensing valve is responsive to the mix-tester.

- 30 31. An apparatus as claimed in Claim 30, further comprising: a shunt valve operable to control the amount of water supplied to the mixer for mixing with the additive.

32. An apparatus as claimed in Claim 31, wherein the shunt valve is responsive to the mix-tester.

33. An apparatus as claimed in Claim 32, further comprising: a blender connected to receive water having a commercially practical degree of purity and mixture from the mixer and operable to blend the water and the mixture to create a floodwater blend.

34. An apparatus as claimed in Claim 33, further comprising: a mix valve operable to control the amount of mixture received by the blender for blending with the water.

35. An apparatus as claimed in Claim 34, further comprising: a main valve operable to control the amount of water received by the blender for blending with the mixture.

36. An apparatus as claimed in Claim 35, further comprising: a blend-tester operable to test a property of the blend within the blender.

37. An apparatus as claimed in Claim 36, wherein the blend-tester is operable to test at least one property selected from the group comprising:

- a) total alkalinity (CaCO_3),
- b) hardness (CaCO_3), and
- c) turbidity.

38. An apparatus as claimed in Claim 37, wherein blend-tester is operable to test at least one property selected from the group comprising:

- a) pH,
- b) bicarbonate alkalinity (HCO_3),
- c) sulphate concentration,
- d) sodium concentration (Na),
- e) calcium concentration (Ca),
- f) chloride concentration (Cl), and
- g) silicon concentration (SiO_2).

39. An apparatus as claimed in Claim 36, wherein at least one of the mix valve and the main valve is responsive to the blend-tester.

40. An apparatus as claimed in Claim 39, further comprising: a mix flowmeter operable to measure the flow of mixture into the blender.

41. An apparatus as claimed in Claim 40, wherein the mix valve is responsive to the mix flowmeter.

5 42. An apparatus as claimed in Claim 39, further comprising: a main flowmeter operable to measure the flow of water through the main valve into the blender.

43. An apparatus as claimed in Claim 42, wherein the main valve is responsive to the main flowmeter.

10 44. An apparatus as claimed in Claim 43, further comprising: a control module responsive to at least one of:

- a) the mix-tester,
- b) the blend-tester,
- c) the mix flowmeter, and
- d) the main flowmeter.

15 45. An apparatus as claimed in Claim 44, wherein at least one of:

- a) the dispensing valve,
- b) the shunt valve,
- c) the mix valve, and
- d) the main valve,

20 is responsive to the control module.

46. An apparatus as claimed in Claim 45, wherein the control module is operable to control at least one of:

- a) the dispensing valve,
- b) the shunt valve,
- 25 c) the mix valve, and
- d) the main valve,

such that the blend has at least one property selected from the group comprising:

- i) $180 \text{ mg/L} \leq \text{total alkalinity (CaCO}_3\text{)} \leq 200 \text{ mg/L}$,
- 30 ii) $9 \text{ mg/L} \leq \text{hardness (CaCO}_3\text{)} \leq 12 \text{ mg/L}$, and

iii) 0 Nephelometric Turbidity Units \leq turbidity \leq 1 Nephelometric Turbidity Units.

47. An apparatus as claimed in Claim 46, wherein the control module is operable to control at least one of:

- a) the dispensing valve,
- b) the shunt valve,
- c) the mix valve, and
- d) the main valve,

such that the blend has at least one property selected from the group comprising:

- i) $7.5 \leq \text{pH} \leq 8.5$,
- ii) $190 \text{ mg/L} \leq \text{bicarbonate alkalinity (HCO}_3\text{)} \leq 210 \text{ mg/L}$,
- iii) $8 \text{ mg/L} \leq \text{sulphate concentration (SO}_4\text{)} \leq 10 \text{ mg/L}$,
- iv) $100 \text{ mg/L} \leq \text{sodium concentration (Na)} \leq 130 \text{ mg/L}$,
- v) $3 \text{ mg/L} \leq \text{calcium concentration (Ca)} \leq 6 \text{ mg/L}$,
- vi) $55 \text{ mg/L} \leq \text{chloride concentration (Cl)} \leq 70 \text{ mg/L}$, and
- vii) $3 \text{ mg/L} \leq \text{silicon concentration (SiO}_2\text{) between } \leq 7 \text{ mg/L}$.